

**Notice of Allowability**

Application No.

10/810,355

Examiner

Herng-der Day

Applicant(s)

BINDEMAN, LEE

Art Unit

2128

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to Amendment received 12/26/07.
2. ☒ The allowed claim(s) is/are 1-15.
3. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
  - a) ☐ All   b) ☐ Some\*   c) ☐ None   of the:
    1. ☐ Certified copies of the priority documents have been received.
    2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
    3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

\* Certified copies not received: \_\_\_\_\_.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.  
**THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.**

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
  5. ☐ CORRECTED DRAWINGS ( as "replacement sheets") must be submitted.
    - (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review ( PTO-948) attached
      - 1) ☐ hereto or 2) ☐ to Paper No./Mail Date \_\_\_\_\_.
    - (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date \_\_\_\_\_.
- Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

**Attachment(s)**

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO/SB/08),  
Paper No./Mail Date \_\_\_\_\_
4. ☐ Examiner's Comment Regarding Requirement for Deposit  
of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☐ Interview Summary (PTO-413),  
Paper No./Mail Date \_\_\_\_\_
7. ☒ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other \_\_\_\_\_

### **DETAILED ACTION**

1. This communication is in response to Applicant's Response to Office Action dated November 1, 2007, filed December 26, 2007, and telephone interview conducted January 4, 2008.

1-1. Claims 1, 6, 7, and 11 have been amended. Claims 1-15 are pending.

1-2. Claims 1-15 have been examined and allowed.

### **EXAMINER'S AMENDMENT**

2. An Examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to Applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

3. Authorization for this Examiner's amendment was given in a telephone interview with Mr. Roger H. Chu (Reg. No.: 52,745) on January 4, 2008.

4. The specification has been amended as follows:

4-1. Replace paragraph [0003] as follows:

--[0003] The user of FEA software creates a model of the system to ~~by~~ be analyzed using elements. An element represents a finite region of the system. Within each element, the unknown quantity is assumed to take a simple form within the domain of the element. For explicit FEA software, the unknown quantity is usually acceleration. For implicit FEA software, the unknown quantity may be displacement, velocity, temperature, or others.--

**4-2.** Replace paragraph [0007] as follows:

--[0007] Solid elements are typically used for modeling thick parts or solid bodies. In three dimensions, a solid element can be shaped like brick or hexahedron. The lowest order brick element has a node at each corner and is thus called the 8-node brick or hexahedral element. The 8-node brick element can be assumed to have a displacement (or other unknown) field that varies linearly along the edges between the nodes. Throughout the element domain, the displacement field has linear terms and cross terms but no quadratics or higher order terms. The compatible stress and strain fields have linear terms within the element domain. There are other types of solid elements such as the 6-node pentahedral element.--

**4-3.** Replace paragraph [0008] as follows:

--[0008] To calculate the nodal forces that are generated by the stress within an element, the calculated stress tensor is multiplied by terms that account for the element's geometry and then integrated over the domain of the element. For many materials, the stress field does not have a linear relationship to the strain field, so closed form integration is not possible. Instead, numerical integration such as Gauss-Legendre quadrature is routinely used. Numerical integration of an 8-node brick element can be done by defining two Gauss-Legendre integration points in each spatial direction for a total of 8 integration points. Such element is said to have full integration or rank sufficient integration. Full integration guarantees that all possible modes of deformation generate stress in the element. Alternatively, numerical integration of an 8-node brick element can be done with a single Gauss-Legendre integration point. Such an element is called an under-integrated or rank deficient element.--

**5.** The claims have been amended as follows:

**5-1.** Replace claim 1 as follows:

1. (Currently amended) A method for controlling hourglass deformations of an under-integrated solid element in a finite element analysis for designing and analyzing a structural product, the method comprising:

establishing a local initial element coordinate system of the under-integrated solid element from an initial undeformed geometry of the solid element;

establishing a local current element coordinate system of the solid element from a current deformed geometry of the solid element;

calculating a set of initial nodal coordinates of the solid element in the local initial element coordinate system;

calculating a set of current nodal coordinates of the solid element in the local current element coordinate system;

evaluating a set of hourglass shape vectors of the solid element from the initial nodal coordinates;

calculating a set of hourglass deformation magnitudes of the solid element as set forth in Equation as follows:

$$\text{Equation: } \hat{g}_{i\alpha} = \sum_{J=1}^N \bar{\gamma}_{\alpha J} (\hat{x}_{iJ} - \bar{X}_{iJ})$$

where:

N = total number of the corner nodes in the solid element,

$J$  = one of the corner nodes,

$\hat{g}_{i\alpha}$  = one of the hourglass deformation magnitudes (spatial direction  $i$  for hourglass mode  $\alpha$ ),

$\bar{\gamma}_{\alpha J}$  = one of the hourglass shape vectors (node  $J$  for hourglass mode  $\alpha$ ),

$\bar{X}_{iJ}$  = one of the initial nodal coordinates (node  $J$  in spatial direction  $i$  of the local initial element coordinate system),

$\hat{x}_{iJ}$  = one of the current nodal coordinates (node  $J$  in spatial direction  $i$  of the local current element coordinate system);

evaluating a set of generalized hourglass forces from the hourglass deformation magnitudes, the local initial nodal coordinates, and material constants of the solid element; and

calculating a set of counter nodal forces for controlling the hourglass deformations in the local current element coordinate system from the generalized hourglass forces and the hourglass shape vectors; and

designing and analyzing a structural product by applying, ~~wherein~~ the set of counter nodal forces ~~is applied~~ in directions opposing to the hourglass deformations such that the hourglass deformations are controlled in the finite element analysis ~~for designing and analyzing a structural product.~~

5-2. Replace claim 6 as follows:

6. (Currently amended) A software product embodied in a tangible computer readable storage medium and executing in a computing device for controlling hourglass deformations of an under-integrated solid element in a finite element analysis for designing and analyzing a structural product , the software product comprising:

program code for establishing a local initial element coordinate system of the under-integrated solid element from an initial undeformed geometry of the solid element;

program code for establishing a local current element coordinate system of the solid element from a current deformed geometry of the solid element;

program code for calculating a set of initial nodal coordinates of the solid element in the local initial element coordinate system;

program code for calculating a set of current nodal coordinates of the solid element in the local current element coordinate system;

program code for evaluating a set of hourglass shape vectors of the solid element from the initial nodal coordinates;

program code for calculating a set of hourglass deformation magnitudes of the solid element as set forth in Equation as follows:

$$\text{Equation: } \hat{g}_{i\alpha} = \sum_{J=1}^N \bar{\gamma}_{\alpha J} (\hat{x}_{iJ} - \bar{X}_{iJ})$$

where:

N = total number of the corner nodes in the solid element,

$J$  = one of the corner nodes,

$\hat{g}_{i\alpha}$  = one of the hourglass deformation magnitudes (spatial direction  $i$  for hourglass mode  $\alpha$ ),

$\bar{\gamma}_{\alpha J}$  = one of the hourglass shape vectors (node  $J$  for hourglass mode  $\alpha$ ),

$\bar{X}_{iJ}$  = one of the initial nodal coordinates (node  $J$  in spatial direction  $i$  of the local initial element coordinate system),

$\hat{x}_{iJ}$  = one of the current nodal coordinates (node  $J$  in spatial direction  $i$  of the local current element coordinate system);

program code for evaluating a set of generalized hourglass forces from the hourglass deformation magnitudes, the initial nodal coordinates, and material constants of the solid element; and

program code for calculating a set of counter nodal forces for controlling the hourglass deformations in the local current element coordinate system from the generalized hourglass forces and the hourglass shape vectors; and

program code for designing and analyzing a structural product by applying, wherein the set of counter nodal forces is applied in directions opposing to the hourglass deformations such that the hourglass deformations are controlled in the finite element analysis for designing and analyzing a structural product.

5-3. Replace claim 11 as follows:

11. (Currently amended) A system for controlling hourglass deformations of an under-integrated solid element in a finite element analysis for designing and analyzing a structural product, the system comprising:

an I/O interface;

a data communications interface;

a memory for storing computer readable code for an application module;

at least one processor coupled to the memory, the I/O device and the data communications interface, said at least one processor executing the computer readable code in the memory to cause the application module to perform operations of:

establishing a local initial element coordinate system of the under-integrated solid element from an initial undeformed geometry of the solid element;

establishing a local current element coordinate system of the solid element from a current deformed geometry of the solid element;

calculating a set of initial nodal coordinates of the solid element in the local initial element coordinate system;

calculating a set of current nodal coordinates of the solid element in the local current element coordinate system;

evaluating a set of hourglass shape vectors of the solid element from the initial nodal coordinates;



calculating a set of hourglass deformation magnitudes of the solid element as set forth in Equation as follows:

$$\text{Equation: } \hat{g}_{i\alpha} = \sum_{J=1}^N \bar{\gamma}_{\alpha J} (\hat{x}_{iJ} - \bar{X}_{iJ})$$

where:

N = total number of the corner nodes in the solid element,

J = one of the corner nodes,

$\hat{g}_{i\alpha}$  = one of the hourglass deformation magnitudes (spatial direction i for hourglass mode  $\alpha$ ),

$\bar{\gamma}_{\alpha J}$  = one of the hourglass shape vectors (node J for hourglass mode  $\alpha$ ),

$\bar{X}_{iJ}$  = one of the initial nodal coordinates (node J in spatial direction i of the local initial element coordinate system),

$\hat{x}_{iJ}$  = one of the current nodal coordinates (node J in spatial direction i of the local current element coordinate system);

evaluating a set of generalized hourglass forces from the hourglass deformation magnitudes, the initial nodal coordinates, and material constants of the solid element; and

calculating a set of counter nodal forces for controlling the hourglass deformations in the local current element coordinate system from the generalized hourglass forces and the hourglass shape vectors; and

~~designing and analyzing a structural product by applying, wherein the set of counter nodal forces is applied in directions opposing to the hourglass deformations such that the hourglass deformations are controlled in the finite element analysis for designing and analyzing a structural product.~~

***Reasons for Allowance***

6. The following is an Examiner's statement of reasons for allowance:

6-1. The closest prior art of record discloses:

(1) A process prescribes second-order tetrahedral elements during simulation in the design analysis of structure (Nagtegaal, U.S. Patent 6,044,210).

(2) A method calculates and adds the element internal forces to the nodes (Forssell et al., "Creating a New Element Type").

(3) A method calculates stabilization forces and stiffness matrix (Belytschko, "Element Technology").

6-2. The prior art of record does not expressly teach or render obvious the invention as recited in independent claims 1, 6, and 11.

Independent claim 1 is directed at a method for controlling hourglass deformations of an under-integrated solid element in a finite element analysis for designing and analyzing a structural product. Although controlling hourglass deformation is obvious in the prior art, this independent claim identifies, as the Applicant argued in pages 14-16 of the Response filed December 26, 2007, and shown in FIGs. 4A and 5A, the distinct combination of features of "establishing a local current element coordinate system of the solid element from a current

deformed geometry of the solid element”, “calculating a set of current nodal coordinates of the solid element in the local current element coordinate system”, “calculating a set of hourglass deformation magnitudes of the solid element as set forth in Equation as follows”, and the recited equation, which has not been uncovered in a single teaching, nor would a modification of prior art references be obvious to one of ordinary skill in the art to yield these limitations in the context of the claim.

Moreover, as the courts have held that “A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference.” *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987) and “The identical invention must be shown in as complete detail as is contained in the ... claim.” *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989). The elements must be arranged as required by the claim, but this is not an *ipsisimilis verbis* test, i.e., identity of terminology is not required. In *re Bond*, 910 F.2d 831, 15 USPQ2d 1566 (Fed. Cir. 1990). Therefore, independent claim 1 is deemed allowable over the prior art of record.

Independent claim 6 is a product claim reciting equivalent method limitations as in the allowable claim 1 and is deemed allowable for the same reason as claim 1.

Independent claim 11 is a system claim reciting equivalent method limitations as in the allowable claim 1 and is deemed allowable for the same reason as claim 1.

Dependent claims are allowed as they depend upon allowable independent claim.

7. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue

fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

*Conclusion*


8. Any inquiry concerning this communication or earlier communications from the Examiner should be directed to Herng-der Day whose telephone number is (571) 272-3777. The Examiner can normally be reached on 9:00 - 17:30.

Any inquiry of a general nature or relating to the status of this application should be directed to the TC 2100 Group receptionist: (571) 272-2100.

If attempts to reach the Examiner by telephone are unsuccessful, the Examiner's supervisor, Kamini S. Shah can be reached on (571) 272-2279. The fax phone numbers for the organization where this application or proceeding is assigned is (571) 273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Herng-der Day  
January 4, 2008 H.D.

  
SPE 2128